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None

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(54) Communications apparatus

(57) In communications apparatus, e.g. remote data/control apparatus, a first unit and a second, remote unit are arranged to exchange messages over a communication channel. To avoid collision between responses between different remote units, the first unit has means for requesting a response from the second unit and means for communicaating to the second unit a value representing a time delay and the second unit has means for monitoring the channel, determining when the channel becomes free and transmitting its response to the first unit delayed by that time delay after the channel becomes free.

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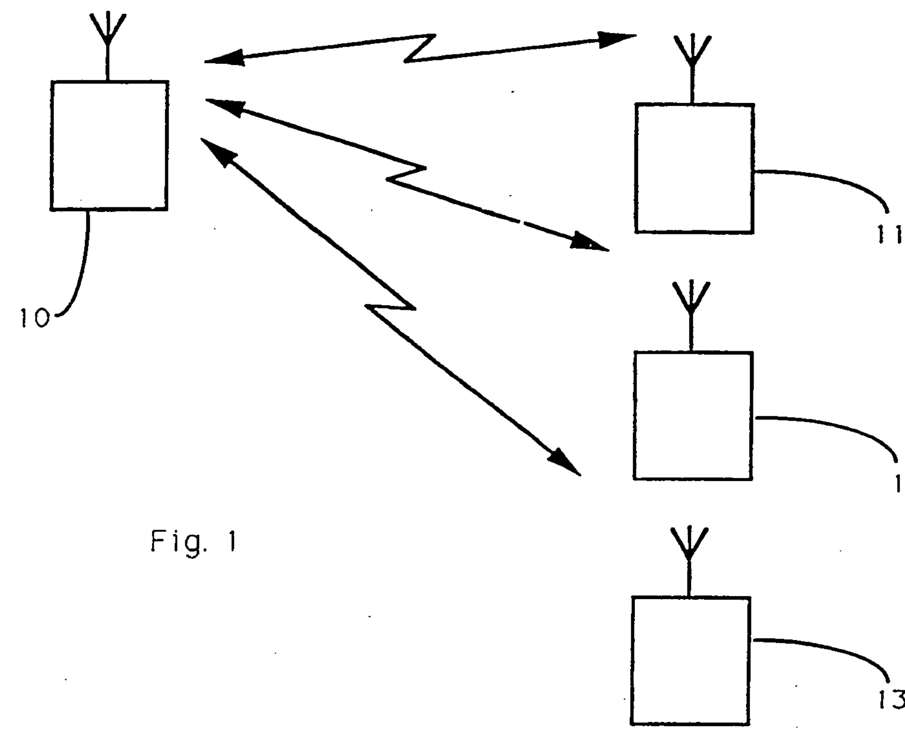
10
11
12
13

Fig. 1

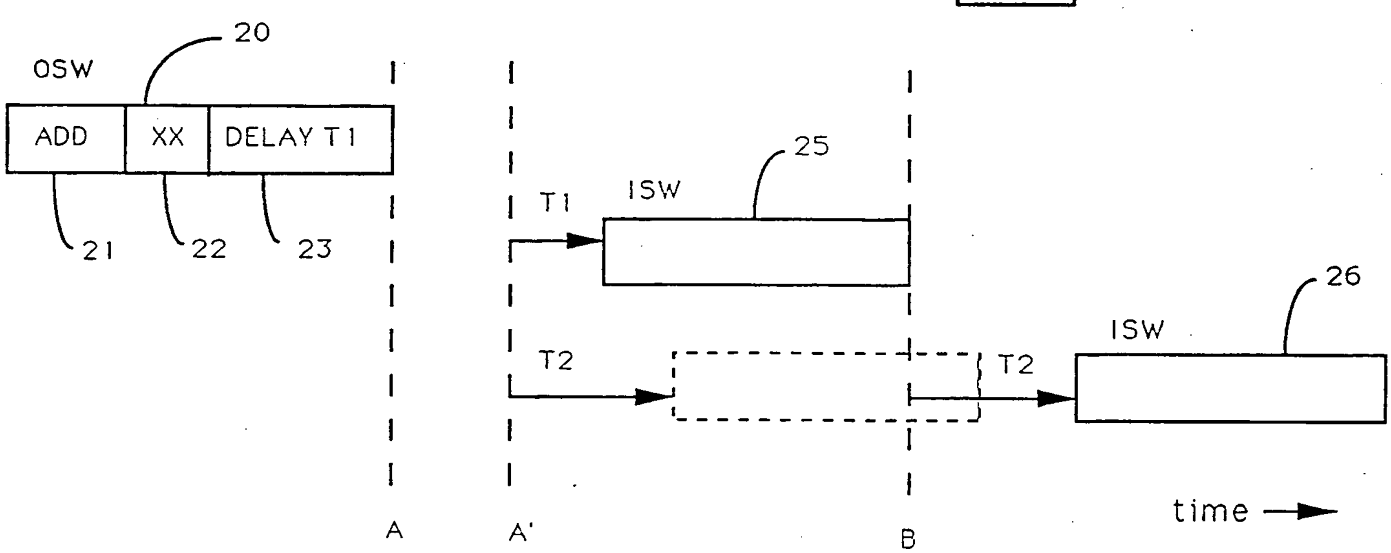
20
OSW
ADD
XX
DELAY T1
21
22
23
25
T1
ISW
26
ISW
T2
T2
A
A'
B
time

Fig. 2

RTU	Time slot	Delay (range 10-200ms)
11	1	20ms
12	2	40ms
13	–	–

Fig. 3

COMMUNICATIONS APPARATUS

Background of the Invention

This invention relates to communications apparatus, such as remote data/control apparatus. The invention relates to improvements in communication protocols and communication systems having several remote terminal units and one or more master control centres communicating by radio, serial ports, dedicated lines and/or telephone lines.

Typical applications include, but are not limited to supervisory control and data acquisition (SCADA) for water and waste water systems, electric utility distribution systems, oil and gas pipelines, early warning siren systems, communication control systems, irrigation control systems and roadside emergency callbox systems.

Summary of the Prior Art

It is a problem that in communication systems comprising a number of units trying to communicate over the same communication channel, collisions occur where different units try to gain access to the channel simultaneously.

In known communications systems, different units are allocated fixed priorities, and gain access according to their pre-assigned priorities.

UK Patent Application No. 2236606A describes a communications system for data acquisition and control in which a contention period is provided during which different remote units can contend for access to the central unit. Different remote units request polling during contention time-slots and are then polled by the central unit during a polling period. When traffic is light, the contention period is reduced so that the remote units can be polled more frequently. Nevertheless, polling does not begin until the contention period ends, irrespective of the number of units contending for polling. The aforesaid arrangement does not address the reverse situation in which a central unit calls for a response from a remote unit.

Summary of the Invention

In accordance with the invention, communications apparatus is provided comprising a first unit and a second unit arranged to exchange messages over a communication channel, wherein the first unit has means for requesting a response from the second unit and means for communicating to the second unit a value representing a time delay and the second unit has means for monitoring the channel, determining when the channel becomes free and transmitting its response to the first unit delayed by said time delay after the channel becomes free, whereby the first unit is able to control the timing of responses from a number of said units and avoid collision between responses from said units.

Brief Description of Drawings

Figure 1 illustrates a remote data/control system in accordance with the preferred embodiment of the invention

Figure 2 illustrates signals transmitted between the units of Figure 1.

Figure 3 shows a table maintained in the central unit of Figure 1.

A preferred embodiment of the invention will now be described by way of example, with reference to the drawings.

Preferred Embodiment of the Invention

Referring to Figure 1, there is shown a central unit 10 and three remote units 11, 12 and 13. The remote units are typically data acquisition and control units which are connected to systems to be monitored or controlled, such as irrigation systems, alarm systems etc. The central unit 10 communications with the remote units 11, 12 and 13, in this example over a radio channel.

Each of the remote units 11, 12 and 13 is able to monitor the channel and determine when the channel is free - i.e. when neither the central unit 10 nor any other remote unit is communicating on the channel. The means for monitoring the channel comprise a received signal strength indicator in the demodulator on the

receiver side of the unit, as is well known in the art (see, for example EP-B-0142503 or GB-A-2012525).

When the central unit 10 wishes to receive data from a remote unit 11, it "polls" that remote unit by transmitting the address of that remote unit and an instruction, which the remote unit interprets as a request for certain data. The data may be, for example, the status of an alarm, the flow rate through a valve etc.

In response to an outbound signalling word (OSW) from the central unit 10 to a remote unit (e.g. unit 11), with an instruction requesting data, the remote unit 11 transmits an inbound signalling word (ISW) with the data requested. The transmission of the ISW can, however, only take place when the channel is free - i.e. when neither the central unit 10 nor any other remote unit 12 or 13 is transmitting. This requirement is satisfied in a manner illustrated in Figure 2.

Referring to Figure 2, the remote unit 10 transmits an OSW 20 comprising the address 21 of the remote unit 11, an instruction 22 and a value 23 representing a delay T1. At the end of the OSW 20, at point A on the time axis, the channel becomes free. At this time, the remote unit 11, and any other remote unit, e.g. unit 12, that wishes to transmit to the central unit 10 measures the signal strength on the channel, and determines that this has dropped below a threshold, and determines that the channel is free. The remote unit takes a finite time to make this determination, and this is represented on the figure by the time A-A'. (In practice there may be other delays between the channel becoming free and the unit 11 being ready to respond, but this is immaterial for present purposes). The unit 11 waits a time T1 before transmitting its ISW. After delay T1, unit 11 transmits its ISW 25 including the data requested. In the meantime, unit 12 has also noted that the channel became free at point A', and unit 12 has initiated a delay T2 before transmitting its ISW 26. The delay T2 may be initiated as a result of an earlier instruction from the central unit 10, or it may be a default delay. At the end of the delay T2, the channel is no longer available, because unit 11 is transmitting its ISW 25. Thus, the ISW 26 from unit 12 is not transmitted (indicated by dotted outline in Figure 2), and instead unit 12 again waits for the channel to become free. When the channel becomes free at point B', unit 12 again waits an

amount equal to the delay T2 and finally transmits its ISW 26 after that delay.

In this manner, unit 11 took precedence over unit 12 in transmitting its ISW, because the delay in unit 11 was shorter than the delay in unit 12. The priority allocated to unit 11 over unit 12 was allocated by central unit 10 by means of the delay information 23 contained in the OSW. In this way, unit 10 has control over the priority allocation between the remote units 11, 12 and 13 in a simple manner over a single channel.

The delay information 23 can take the form of a number of discrete delay values. Each of these discrete delay values represents a time slot during which the remote unit will transmit its response. The central unit 10 stores a table correlating addresses of remote units with time slots. This table is shown in Figure 3.

As illustrated in that Figure, remote unit (RTU) 11 has been allocated time slot 1 corresponding to a delay of 20 milliseconds and RTU 12 is allocated time slot 2 corresponding to a delay of 40 milliseconds. These delays represent the time each unit waits after any channel becomes free before transmitting.

When the central unit 10 receives an ISW from a remote unit, it releases the time slot previously allocated to that unit, for future allocation. Thus, in the table shown, RTU 13 has no time slot allocated to it, because the central unit 10 is not awaiting any response. Thus the central unit 10 can allocate any time slot from time slot 3 upwards to RTU 13.

When a remote unit wishes to report to the central unit without first being instructed by the central unit (e.g. to report an emergency), the remote unit allocates a time slot to itself, which may be a default time slot such as the first or last time slot or it may be a time slot plus offset (i.e. a time sub-slot) which may be unique to that unit or is pseudo-random.

The time delay T1, T2 etc. and thus the position of the time slots is fixed, but is optimised according to the minimum sensitivity of the communication channel, i.e. how fast a remote unit recognises channel monitor (busy channel) after another remote unit has activated its push-to-talk. Thus the response time to the first message attempt from the centre is independent of the remote unit

addresses, and the desired function is achieved of remote units responding optimally without collisions.

The number of assigned time-slots is limited per transmission burst, so that there will be no need to assign one time-slot for each remote unit, since this would considerably prolong the response time. Thus a system with 100 remote units, may utilise, say, only four time-slots. Once a remote unit has responded in its time-slot, this time-slot becomes free and can be used again by another remote unit in the next transmission.

It should be noted that if the first transmission fails for any reason, subsequent responses from the remote unit revert to a response scheme similar to prior art schemes, i.e. using a pseudo-random delay based on the remote unit address but multiplied by the minimum channel selectivity time (typically 100 milliseconds). This is done in order to increase the probability of success, if the first time-slot technique did not succeed for any reason. The use of the channel sensitivity time as a factor even to subsequent responses, as proposed by this invention, adds a new level of channel optimization and probability of success not available in prior art systems.

Claims

1. Remote data/control apparatus comprising a first unit and a second unit arranged to exchange messages over a communication channel,

the first unit having means for requesting a response from the second unit and means for communicating to the second unit a value representing a time delay and

the second unit having means for monitoring the channel, determining when the channel becomes free and transmitting its response to the first unit delayed by said time delay after the channel becomes free, whereby the first unit is able to control the timing of responses from a number of second units and avoid collision between responses from said second units.

2. Apparatus according to claim 1, wherein the first unit has means for selecting said value from a predetermined number of values defining a predetermined number of timeslots, and means for allocating different timeslots to different second units from which it has requested responses.

3. Apparatus according to claim 2, wherein the first unit has means for reallocating a timeslot to a new second unit after the previous second unit to which that timeslot has been allocated has responded.

4. Apparatus according to any one of the preceding claims wherein the second unit comprises means for transmitting a message of its own accord, further comprising means for delaying the transmitting of the message by a predetermined time after the channel is determined to be free.

5. Apparatus according to claim 4, wherein the first unit comprises means for selecting the value from a number of values representing a number of time delays and wherein the predetermined time is longer than the longest of said time delays.

6. Apparatus according to claim 4 or 5 wherein the predetermined time is a pseudorandom time.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

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Relevant Technical fields

(i) UK Cl (Edition K) G4H (HNNA), H4P (PPND)

(ii) Int Cl (Edition 5) H04L

Search Examiner

M J DAVIS

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

25 OCTOBER 1991

Documents considered relevant following a search in respect of claims 1-6

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

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Category	Identity of document and relevant passages	Relevant to claim(s,

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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